A FEW GENERAL DIRECTIONS WITH REGARD TO DESTROYING MOSQUITOES, PARTICULARLY THE YELLOW FEVER MOSQUITO.

As this article is not intended for the reading of people who have given any particular attention to the facts at present known of the way in which the mosquito carries disease from one person to another, I think it best to briefly call attention to the leading points in our present knowledge of this subject.

Malaria and yellow fever are the two great diseases with which the mosquito is concerned. They are by far the most important diseases in the tropical countries of the Western Hemisphere, and play a great part in the sickness of the southern part of the United States. Up to twenty-five years ago it was universally believed that malaria was caused by a gas, or miasm, arising from the decomposition of dead vegetable matter in hot countries, but about that time a French army surgeon in Algeria, Laveran by name, noticed that if he looked sufficiently carefully with his microscope, in the blood of persons suffering from malaria, he could almost always find a very small animal parasite. This little, living being got into the blood in some way, Laveran did not know how, fed upon the red blood corpuscles, and was apparently the cause of the disease which we call malaria. Laveran's discovery was a great advance in our knowledge of the disease, and it was gradually accepted by all the medical world.

A careful search was made for the parasite by many investigators, but it could only be found in the blood of human beings suffering from malaria. Where else it was bred and how it got into the blood of man no one could find out. About this time it was discovered by an English army surgeon, Doctor Manson, that a small worm—the *Filaria sanguinis hominis*—was introduced into the body by the bite of a mosquito. (This worm causes the disease among human beings known as filariasis, and to it are due the enormous and unsightly swellings of the legs and other parts of the body seen by our people in Cuba and the Philippines. It is, however, a disease very rarely found in the United States, and not of much importance to us. I only mention it here in connection with my story of the mosquito.)

About fifteen years after the discovery of Laveran, that malaria was due to an insect in the blood, and of Manson, that a certain worm which caused disease was introduced into the human blood by the bite of a mosquito, another great English army surgeon, Ronald Ross, discovered that the malarial parasite was found in a certain species of mosquito—the anopheles—after the insect had bitten a human being suffering from malaria. With his miscroscope he followed the life history of this parasite, from the stomach of the mosquito, through the walls of the stomach into the mosquito's body, and finally into its

salivary glands. In the saliva of the mosquito, the little organism was found in large numbers, and when biting man, for the purpose of getting blood, the mosquito injects her fatal saliva, just as does the rattlesnake when he bites. This discovery of Doctor Ross was demonstrated in the most positive manner.

An Italian, living near Rome, in Italy (malaria is very bad in the neighborhood of Rome), while suffering from a malarial attack, was bitten by an anopheles mosquito. This mosquito was then taken to London, England, where they have no malaria, and a healthy young man, who had never had malaria, was bitten by her. In a few days the young man had a well-marked attack of malaria, with the usual symptoms, and the malarial parasite was seen by the microscope circulating in the blood of the patient and feeding upon the red blood corpuscles of his blood. And, again, men were taken, put into houses, screened so that mosquitoes could not get in, and spent weeks in this unhealthy part of Italy without getting sick. Yet this particular part of Italy is considered so unhealthy that during the summer season neither native nor foreigner, who can avoid it, spends a night there.

A night spent in the Campania used to be thought a certain way to contract malaria; the idea being that the foul air from the marshes caused the disease. Yet it is now seen that entirely unacclimated men can breathe this air with safety, provided only that they live in screened houses and are not bitten by mosquitoes. These and similar facts convinced the scientific world that the malarial organism gets into the blood of the human being through the bite of the anopheles mosquito, and in no other way.

Before the year 1900 it was universally believed that yellow fever was carried from person to person and spread generally by a germ, which up to that time had not been discovered. The germ was supposed to travel from person to person by contact with those sick of the disease, or by means of clothing or other articles which had been near the sick, and its development was believed to be greatly favored by all conditions which increased filth. There were a good many facts in the spread of the disease which were difficult to account for under this supposition, but nevertheless it was the best explanation possible, and, as I said, was almost universally accepted, both by physicians and people generally.

During the year 1900 the Army of the United States had entire control of Habana, at that time the great center of yellow fever for the world. An excellent opportunity for investigating the disease therefore existed. The Surgeon-General of the Army sent to Habana a board of army medical officers for the purpose of investigating yellow fever. This board was made up of the following army doctors: Doctor Reed, the president, and Doctors Carroll, Agramonte, and Lazear. After much investigation they determined to study the relation of the mosquito to yellow fever. Their attention was called to this matter by the part that the mosquito had already been proved to play in malaria and filariasis, as mentioned above, and also by certain facts known in the history of yellow fever epidemics. Doctor Finlay, a prominent physician of Habana, reasoning from certain peculiarities of yellow fever and from experiments which he made, had maintained for many years that a certain kind of mosquito in Habana, the *stegomyia*, was the cause of yellow fever, but he had not been able to prove it.

The army board of which Doctor Reed was president recognized that in Cuba, where they did their work, it would have to be entirely evident that the men experimented upon could not get yellow fever accidentally in Habana, or anywhere else, but only, if at all, in the course of the experiment. They therefore took a piece of unoccupied ground about six miles from Habana and built there a camp of material which could not have been infected with yellow fever. They then got men who had never suffered from yellow fever and placed them in these tents. It was known that if a man exposed to yellow fever were going to have it the disease would develop in less than six days, and if he passed through six days safe and sound he was known to have escaped that particular exposure.

The board therefore argued that if they kept their men in this camp for a period of two weeks they would be safe from any exposure which might have occurred before their coming to the camp. They also had to provide means which would insure their men not leaving the camp, contracting the disease outside, and thus bringing infection into the camp. This was done by a military guard, who allowed no one to go out or come in without Doctor Reed's permission. Things were now so arranged that if a mosquito was allowed to bite a man, and yellow fever developed, the board could be certain that the yellow fever was due to the bite of the mosquito alone. They did a great deal of experimenting here before they worked out all the details of the way in which the mosquito actually conveys yellow fever. They finally found out that if a female mosquito of one particular species, the stegomyia, was applied to a yellow-fever patient in the first three days of his sickness, and then kept from ten to twenty days and allowed to bite a human being who had never had yellow fever, he would very generally develop the disease within six days after the bite.

They also found out that this same man, before he had been bitten by the yellow-fever mosquito, could sleep in the bed in which a patient had died of yellow fever, could be covered with a black vomit from a yellow-fever patient, or be exposed to the emanations from yellow fever in any other way, and as long as he was kept safe from the bite of the mosquito he would not have yellow fever; but this same man, after all this exposure, if afterwards bitten by an infected yellow-fever mosquito, would very certainly catch the disease. I think it would be interesting to give some of the details of the work by which this great discovery was demonstrated.

They had a little frame building built in this camp furnished with jars and the necessary simple material for breeding mosquitoes. The building was carefully screened and guarded, so that mosquitoes could not get in nor out. Eggs of this particular species of mosquito were obtained and hatched in one of the jars. A female mosquito was taken from the brood thus hatched. The male mosquito will not bite, and can readily be distinguished from the female with a magnifying glass by the fact that the male has very heavy feathery feelers (antennæ) growing from his head. The female mosquito selected was put into a small glass tube, stoppered with a little cotton, so that she could get air freely but not escape, taken to Habana, placed on the hand of a patient in the first three days of an attack of yellow fever, and allowed to fill herself with blood. She was then brought back to her former home, placed in a large glass jar, and allowed to digest the blood she had obtained. The jar, covered with a piece of mosquito netting, had

in it a small saucer with a little water, and a lump of white sugar was also provided. Under these conditions the mosquito was furnished with all the necessities of life.

So confident were the men in charge of the mosquitoes that I have known them to put their hands in the jars and let the mosquitoes feed upon them, up to the fifth or sixth day after the mosquito had bitten a yellow-fever patient. The mosquito, you recollect, can not convey the disease till from twelve to twenty days have passed from the time of her biting the yellow-fever case from which she becomes infected.

On the other hand, I once saw a party of twelve or fifteen doctors in the mosquito room one day, when the mosquito-bar covering of the jar accidentally came off and the insects escaped into the room. These doctors had come from other countries to investigate the subject, and were not then convinced that the mosquito carried yellow fever. Still, they did not care to put the matter to a practical test in their own persons, and got out of the room so rapidly that the wire-screen door was broken down during their exit. It happened that the mosquitoes in this jar had never bitten a yellow-fever patient and were not infected.

After the mosquito had been left in this condition for from ten to twenty days, it was known that her saliva was capable of transmitting the disease. When she was wanted for the purpose of giving somebody yellow fever, a man would take a glass tube, slip his hand under the mosquito netting, put the mouth of the tube over the mosquito, and then fill the mouth of the tube with a cotton stopper, as above described. She would then be taken to the man to whom it was desired to give yellow fever and who had bravely volunteered for the purpose, the cotton stopper taken out, the tube turned upside down with its mouth resting on the skin, and the mosquito allowed to settle. She would then introduce her biting apparatus and slowly fill herself with blood. But before she fills with blood she injects her saliva into the wound, just as does the snake in biting. It is this injection of the saliva that causes the swelling and the burning sensation that is felt at the point where the mosquito bites and which lasts some time after she has finished. The injection of the irritating saliva probably has the effect of making it easier for the mosquito to get blood.

Now, it will be remembered that this man who was bitten had been kept in the camp for two weeks before he was bitten, and isolated in such a way that he could not possibly have contracted yellow fever. There were thirty or forty men in the same camp under exactly the same conditions. Three or four days after he was bitten by the mosquito he developed a well-marked case of yellow fever, although everybody else in the camp remained well. Doctor Reed and his fellow-workers, therefore, very naturally believed that that particular mosquito gave the man yellow fever. They repeated this test twelve or fifteen different times with the same result. Nobody else in the camp had yellow fever. Always within six days after the bite of the mosquito known to be infected, the man experimented upon had yellow fever.

To show how a house could become infected with yellow fever, the board conducted the following experiment: They built a large room and screened it so that mosquitoes could not get in or out. (Whenever I use the word "screen" here I mean the ordinary wire netting or mosquito bar.) The purpose is of course to leave a perfectly free circulation of air, but to have the meshes of the wire or mosquito bar

netting so small that a mosquito can not get through. They then divided this room into two parts by a wire netting extending from top to bottom, so that a mosquito could not pass from one side to the other, but at the same time leaving the circulation of air entirely free, the desire being to show that if it were any miasm, or emanation, or germ floating in the air which caused yellow fever it could freely pass from one side to the other of this netting, and that both rooms, as far as these emanations were concerned, were in the same condition.

Now, to show that the building was uninfected, four men were put in it who had never had yellow fever, two sleeping on each side of the wire netting. They were left there for two weeks and remained perfectly well. Reed then said, "I am now going to infect the room on one side of this wire netting with yellow fever and not infect the other side." He took the two men out of one side and liberated a half dozen infected female *stegomyia* mosquitoes on this side. The two men still slept and lived on the uninfected side. He then put a volunteer on the side with the mosquitoes and left him there for half an hour, took him out, and within six days this man developed yellow fever, the two men on the other side of the room remaining well.

He therefore argued that, as the two men who had been for so long a time on one side of the wire netting and remained well were breathing the same emanations, and the only difference was that there were mosquitoes on the infected side to which the man had been exposed for half an hour, it was very good proof that the mosquito was the factor which gave yellow fever. He then said, "Now that I have shown you a house infected with yellow fever, I will demonstrate how it can be disinfected and rendered safe." He then caught his half dozen mosquitoes, bottled them up and put them back into their jars, and announced that the building was entirely safe and uninfected, put the two men back into the side which had been infected, and the four continued to sleep and live as safely in these quarters as they had before the infection.

The board had another room built and got all sorts of material infected by yellow-fever patients from the hospital, clothing worn by patients at the time they died of yellow fever, such as mattresses on which they died, soiled in every possible way, pillows and pillowcases saturated with black vomit, and blankets over which basins of black vomit had been poured; in short, material infected by yellow fever in every possible way that could be thought of. All this material was placed in the room, which was made close and tight with very little ventilation, so as to make the conditions most favorable for what was ordinarily considered the best way of insuring the spread of yellow fever. Volunteers who had never had yellow fever were placed in this room, lived and slept there for two weeks at a time, wore this clothing, slept on these mattresses, under these sheets, and yet not a single case of yellow fever was developed from this contact. The men who had undergone this exposure were taken out and kept for two weeks so as to insure that they had not contracted yellow fever from the exposure, and then bitten by infected mosquitoes. They always got yellow fever from the bite of the mosquito, but never in any other way.

At this time the military authorities had had entire control of Habana for about two years. An army doctor had been placed in charge of the health department and given the means and power to do what he thought most likely to free the city from yellow fever.

Yellow fever in Habana was a disease like consumption in Galveston or New Orleans—always there, and always one of the principal causes of death in the city. And this had been the state of affairs as long as anything had been known with any accuracy, either about yellow fever or about the health conditions of Habana; and these things were pretty accurately known for more than a hundred years immediately preceding the time I refer to. When we organized our health department, we believed, as did everybody else, that yellow fever was caused by filth, dirt, and general insanitary conditions, so we went to work doing our very best to correct these conditions. With these efforts Habana very rapidly became a healthy city, as much so as many of our large cities in the United States, but yellow fever did not seem to be affected.

The second year of our control yellow fever was very severe in Habana, but did not attack the native Cuban because he was generally acclimated. Only the foreigner, therefore, was subject to the disease. During the year 1900 many of our prominent American civilians and military officials died of the disease, and the very cleanest and best parts of the city and the people who lived best and took the best care of themselves were most affected. When the army board published their discovery to the world the health department of Habana recognized that it and all the rest of the world had been on the wrong track with regard to yellow fever, and they determined to change their methods and attack the mosquito as the cause of the disease.

They had been convinced by the work of the army board that a human being could only get yellow fever by being bitten by a particular kind of mosquito—the stegomyia—which had previously bitten a man suffering from yellow fever. They therefore arranged that as soon as a man sickened with yellow fever, employees from the department went to the house and screened it with wire netting, so that those mosquitoes that were in the house could not get out and those outside could not get in. A smudge was then made of sulphur, tobacco, or insect powder, as best suited to the circumstances, in the affected house, and in all those immediately around it, with the intention of killing all mosquitoes present. By this method it was hoped that both the mosquitoes that had bitten the man and caused the disease would be killed, and also those that had bitten the man after he was taken sick, and had thus become themselves infected and able to spread the disease. For the purpose of doing this screening a building was arranged very much like a fire station in one of our cities, where wagons, wire screens, carpenters, and men with material for making a smudge, were always kept on duty, who proceeded at once to the place where a yellow fever case was reported to exist.

This method was very successful in its results. After its adoption very few cases occurred where the disease spread from the person infected to others in the neighborhood. It was also determined to destroy as many as possible of the yellow fever mosquitoes in the city. It was known that the female mosquito had to have water on which to lay her eggs, and that these eggs could not hatch without water; that this water had to be very quiet and well protected for the hatching process to take place; that the eggs took about three days to hatch; that after hatching the insect had to live the life of a fish in this water for five or six days. During this fish stage they are known as larvæ, and are well known to everybody in the South, for they are nothing

but the common wigglers always found in standing rain water during the summer months. Now, while in this wiggler stage the insect has to have air, and for this purpose must every little while come to the surface. At the end of five or six days the wiggler changes into the full-grown mosquito.

It is known that this particular species of mosquito—the stegomyia, or the yellow fever mosquito—lives and breeds almost altogether in houses and in their immediate neighborhood, and does not leave the house for any great distance. With this knowledge of its life history, the department found it easiest to destroy the mosquito in its wiggler stage, and the most useful means in this direction they found to be the doing away with all the little deposits of water in and near inhabited houses, which the wiggler must have in order to develop into the mosquito. The methods herein described were not settled upon, as might appear from this account, all at once and at the beginning, but many other methods of waging war against the mosquito were tried, found impracticable, and dropped.

With the object of doing away with the breeding places of the yellow fever wiggler all the houses and yards of Habana were carefully examined and all tin cans, empty bottles, and trash of the same kind, which were generally found filled with rain water, and full of yellow fever mosquito larvæ were carefully carted off. Then the necessary openings in all cisterns were covered with mosquito netting, so that the mosquitoes could not get in to lay their eggs. Among the poorer people, who had only barrels and other similar receptacles for rain water (and in Habana every family had something of this kind), the health department arranged these necessary receptacles for them by placing a wooden cover on the barrel, leaving a hole in the center of this cover for the entrance of water, and covering the hole with wire netting, so that mosquitoes could not get in. To enable them to draw off the water without opening the barrel a cheap wooden spigot was placed in the lower part.

Now from the peculiarity of the wiggler, that he has to come to the surface of the water every few seconds to get air, if we put anything on the surface of the water that prevents him getting this air, he drowns just as certainly as a man would who is kept under the water. Ordinary kerosene oil, a tablespoonful or two to a cistern, spreads over the surface of the water and kills the wiggler in this way. He can not break through the scum of oil to get air. But oil very rapidly evaporates and has frequently to be renewed. So oil was only used in Habana where no other method was successful. The privy pits in all the houses there were in the center of the court, covered generally with heavy flagstone. These pits not being in general accessible to the inspectors had to be treated with oil. Once a month, a couple of ounces of oil were poured into the pipes leading to the pits.

To insure that these methods and ordinances were carried out, the city was divided into districts of about a thousand houses each, so that an inspector would get over each district in the course of a month, inspecting at the rate of about thirty houses a day. This inspector had with him two men who used the oil as above described. He had with him printed blanks on which he entered the condition of the premises as to wigglers. These reports were turned in every night to the office of the health department and were consolidated from day to day. At the end of the month we could therefore tell the condition

of Habana as to wigglers. At the first report on this subject (I think in March, 1901), we found that we had in Habana in the neighborhood of 26,000 different water deposits which contained wigglers, most of them of the yellow-fever variety.

After once going over the city and carefully explaining to the people the dangers of allowing wigglers on their premises, and after having fixed up for the poor all the water barrels which they were obliged to keep for holding their rain water, the mayor of the city issued an ordinance stating that anybody who bred wigglers on his premises would be fined $10. These two methods of destroying yellow fever mosquitoes, namely, that of killing the grown mosquito in the neighborhood of every yellow-fever patient with a smudge and of looking after the wigglers in all rain water deposits about the house, were steadily enforced during the year 1901. The results were better than we had dared to hope. Few cases occurred in which yellow fever spread from a case cared for in this way. Yellow fever rapidly decreased, and on September 28, 1901, the last case of yellow fever occurred in Habana, and since that time—now more than two years—not a single new case has developed in the city.

There were still, of course, a great many yellow-fever mosquitoes in Habana, but these methods of destroying the wigglers had greatly decreased the numbers of mosquitoes. The report of January, 1902, after about ten months of this mosquito work, showed that within the city limits less than 300 premises had wigglers upon them. This I think a very fair measure of the results accomplished by one year's work, namely, that the number of deposits containing wigglers had been decreased from about 26,000 to about 300.

I think it is evident that the disappearance of yellow fever from Habana was due solely to this mosquito work. Remember that it was an every-day disease in Habana, and had been so for more than a hundred years, just as consumption is in New Orleans, a city of about the same size as Habana. Now, if some method should be adopted against consumption in New Orleans, and systematically put in operation in the city against that disease, and at the end of a year it could be shown that no new cases of consumption were occurring in New Orleans, and at the end of two years and a half it could be further shown that under the continuance of the same measures the disease had entirely disappeared from the city, and no new cases had occurred, I should think that we would all be at once convinced that the disappearance of consumption from New Orleans was due to the efficacy of the measures adopted.

In Habana, even now, a case or two of yellow fever comes in every month from Mexico and other infected regions which have a considerable trade with Habana. The ships are carefully inspected by the quarantine authorities, just as is done in our country. If a person sick of yellow fever, or suspected yellow fever, is discovered, he is landed at the city wharf, in the heart of the business district, placed in an ambulance, carried to the yellow-fever hospital, which is well within the city limits, and treated there. The only precaution taken is to see that Habana mosquitoes do not get an opportunity to bite him. The authorities at Habana thoroughly believe that if they can prevent mosquitoes from biting a yellow-fever patient the city will be entirely safe in handling him and taking care of him.

In 1901, during the height of the yellow-fever work at Habana, a town of about 5,000 inhabitants, some 12 miles from the city, became badly infected with yellow fever. This town, Santiago de las Vegas, was practically a suburb of Habana, and the business communication with the city was very intimate. We found that people who were working at Santiago de las Vegas were constantly getting sick of yellow fever, and as soon as they found themselves sick would come into Habana to the homes of their friends and relatives to be taken care of. In order to do away with this source of danger a large force of men was put at work at Las Vegas, on the lines above described. The whole town was systematically gone through from house to house, and at the end of about six weeks of this work the disease was entirely wiped out and we had no more trouble with infection from Las Vegas. I mention this as showing the possibility of taking a small town and getting rid of the disease rapidly by mosquito work.

We had other mosquito work going on in the suburbs of Habana, among the truck gardens and irrigated fields where grass was grown. But the yellow-fever mosquito does not breed to any great extent in such places, and I do not think this work had much effect upon the yellow fever. But malaria, as I have above mentioned, is also carried exclusively by a mosquito named the "anopheles." Now, this malarial mosquito likes to breed in places where there are little puddles of water, cow tracks, horse tracks, and similar depressions in grassy ground, and the work in the suburbs had its principal effect upon this mosquito. It was not desirable to stop irrigation, as the livelihood of all these small farmers depended upon it, but by taking advantage of the fact that a deposit of water had to remain undisturbed at least ten days to breed a mosquito, we could allow them to irrigate freely, provided the water did not remain longer than a week. The health department had all this area arranged with shallow, superficial ditches which would not interfere with irrigation, but would allow rapid drainage when the water was taken off. All pools and puddles which had no economic use were kept drained, and ditches and streams kept clean of grass and obstructions.

After once getting the country cleaned up at public expense, and the matter explained to the farmer, he was fined in the same way as the householder in the built-up portion of the city, if wigglers were discovered on his premises. While I do not think that these measures aided us particularly in yellow fever, they had a marked effect upon malaria. In 1900, the year before the mosquito work commenced, we had in Habana 325 deaths from malaria. During 1901, the year in which mosquito work was commenced, we had 151 deaths from malaria. In 1902, the second year of mosquito work, Dr. Carlos Finlay, the health officer of Cuba, reports 77 deaths from malaria in Habana, and up to the 1st of November in 1903, the third year of mosquito work, Doctor Finlay reports 45 deaths from malaria.

This mosquito work of the Habana health department, I hold, demonstrates the practicability of eliminating in the Tropics—the two diseases malaria and yellow fever—and I believe if the attention of the people at large in our own country were generally attracted to the danger of transmitting disease by the mosquito, and the practicability of destroying them, we could very generally eliminate these two diseases from our own country.

And now to the reason for writing this article. I thought an account of the relations of mosquitoes to disease, given in simple terms, readily understood by those who are not doctors, might help people generally in making an attempt to get rid of mosquitoes, each man about his own house. I will now proceed to make suggestions in this direction. And in order to make myself entirely clear will repeat a good deal, and enlarge upon what I have already said.

The work of the army medical board of which Maj. Walter Reed was president, showing that a particular species of mosquito was the only means of transmitting yellow fever, is now pretty generally accepted by all the scientific world. Based upon this knowledge, certain methods were adopted by the army medical officers in Habana, Cuba, which resulted in eradicating yellow fever from that city. During the fall of 1903 yellow fever was introduced from Mexico and became quite widely spread through western Texas. It is thought that a few general rules, based upon the knowledge acquired by the army board and the experience of the army medical officers in Habana, may be of use in assisting individuals and towns in freeing themselves from infected mosquitoes during the present winter and coming spring. Otherwise, it seems highly probable that yellow fever, at some point in Texas, will again develop as the warm weather comes on. This would come about from the fact that the infected mosquito can very readily live through the winter in the latitude of Laredo.

As yellow fever can only be spread by a particular species of mosquito, it follows that if there are none of these mosquitoes about, yellow fever can not spread. The danger in Texas is that the stegomyia mosquitoes, that have bitten people with yellow fever, will live through the winter and spread another epidemic as the warm weather comes on by biting people who have not had the disease. This mosquito, from its nature, stays immediately about the house and in the rooms, and seldom or never wanders far. It was found in Habana that by destroying all the mosquitoes in each house where yellow fever occurred the disease was always stopped in that particular neighborhood. It is probable, therefore, that if each householder in whose house yellow fever has occurred during the past fall will destroy all the mosquitoes in his house he will be free from the old infection next spring. This can readily be done by closing the room and making a smudge in it of sulphur or tobacco. Care should be taken to paste all the cracks up with paper, so that the smudge will be confined to the room fumigated, and the pan in which the smudge is made placed on a little earth, so that it can not set the floor on fire.

With sulphur, about a pound to a room 10 feet square should be used, and with tobacco, about half a pound. To start the sulphur burning a couple of tablespoonfuls of alcohol should be poured on before applying the match. Sulphur should be used unless the room contains valuable material which might be injured by it. The fumes of tobacco hurt nothing, but leave a disagreeable odor. The fumes of ordinary Persian insect powder hurt nothing and leave no odor, but it does not always kill the mosquitoes and care has to be taken to sweep them up afterwards. A couple of hours will be time enough to keep the room closed. After that time it can be opened, aired, and occupied. In towns, this method should be carefully carried out during the winter by the town authorities. Not only the houses in which yellow fever is known to have occurred, but every house in the infected

town should be treated in this way. We found in Habana that a squad of five men, under intelligent direction, could easily fumigate a 10-room house in two hours. It should be arranged so that the whole of the infected town should be gone over before the 1st of April.

The above directions cover the points with regard to killing infected mosquitoes, and thereby preventing the liability of a new epidemic next summer from the old mosquitoes left over from last year. But it is even more important to prevent the breeding of a new crop of *stegomyia* mosquitoes, and this can be very readily done without very great effort.

The female *stegomyia* mosquito always seeks some small body of well protected fresh water in which to lay her eggs. On the surface of this water she lays about 60 or 70 eggs. These, in warm weather, in three days hatch out into the ordinary wiggler, and the wiggler in five or six days develops into the full-grown mosquito. From the laying of the egg to the development of the full-grown mosquito takes about eight days in hot weather. Water is as necessary to the insect as it is to a fish. It is essentially a water insect during this period, though it is an air-breathing insect too, and has to come to the surface of the water every few seconds to get air.

As I stated above, the *stegomyia* seeks particularly deposits of clean water, and is essentially a house mosquito, breeding either in the house or very close to it, in such places as cisterns and rain-water barrels, and in anything likely to catch and retain rain water, such as old bottles or cans, or gutters under the roofs of houses, etc. Now, if every householder will give a little attention to see that there are no such deposits about his house, he will be free from the *stegomyia* mosquito, and no one will contract yellow fever in his house, even if cases are introduced into it from elsewhere. If necessity obliges him to keep a cistern or barrels of rain water, if he will arrange the receptacle so that the mosquito can not get in to lay her eggs, it will be entirely safe. In the cistern this can be done by covering the top tightly, with the exception of a hole for ventilation, and one for the entrance of the water, and these two holes should be covered with wire netting. The netting should be not larger than 16 meshes to the inch. A larger mesh than this will allow the smaller size of *stegomyia* to pass through.

Water barrels can be arranged in the same way, a tight-fitting top put on, with a wire mesh over the hole for the entrance of the water, and a cheap spigot put in the bottom for drawing off water. If he finds wigglers in any of the vessels of water which he is obliged to keep, he can know that his cover is imperfect, and that the female mosquito has gotten in there in some way to lay her eggs. Small deposits about the yard and in the immediate neighborhood should be swept out or drained away. A deposit of water in Texas would have to stand at least ten days to breed a mosquito. For this reason, if the householder is not able to arrange his water vessels as above suggested he could avoid breeding stegomyia mosquitoes by having these vessels emptied once a week. But if the method of emptying is used, the larvæ should be carefully washed out or the vessel left to stand empty for more than an hour. If this precaution is not taken, a considerable number of the larvæ will be left adherent to the bottom and sides and will live if the vessel is at once refilled. Kerosene oil is fatal to the larvæ if two or three tablespoonfuls are spread over the surface of the water.

As I said before, the larvæ have to come to the surface every few seconds to get air, and as they are unable to break through the film of oil they die of suffocation, but the oil evaporates very rapidly and should be renewed every week. Much the better method is either to get rid of the deposit of water or protect it in the above-mentioned manner. Oil should only be relied upon in treating deposits in a building or its immediate neighborhood which can not be managed in one of the above-mentioned methods. Privy pits which contain water were the only places in Habana in which we habitually resorted to oil.

In towns these methods should be enforced by regular and systematic inspections. In most towns there are ordinances against pigs and pigsties. A hog is considerably larger than a mosquito wiggler, but with a little care an inspector will soon learn to discover the wigglers almost as easily as the hogs. And the householder should be taught that the wiggler causes a great deal more annoyance to himself and his neighbors than the hog does, and is infinitely more dangerous to health. And the ordinances should hold the householder as strictly to account for breeding wigglers on his premises as for having a pigsty with a litter of pigs. The larger deposits, a hundred yards or more away from the house, such as small ponds and swampy places, while breeding mosquitoes that cause a great deal of annoyance, will not breed the stegomyia to an extent sufficient to be dangerous to the house. They should be managed by the town authorities on the same general principles—to drain wherever possible.

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